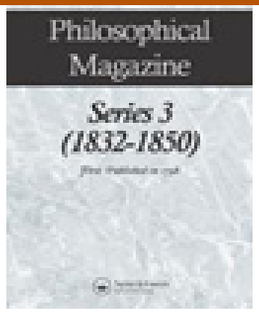

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XXV. On certain new combinations of albumen, with an account of some curious properties peculiar to that substance

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the present results are sufficiently important to justify us in submitting them to the public through the medium of your Magazine. We remain, Gentlemen, yours, &c.

Toomavara, Tipperary, July 1836.

T. Knox,
Geo. J. Knox.

Explanation of Figures.

Fig. 1. The vessel with the receiver in the stand which holds down the receiver by means of spiral springs A.

Fig. 2. Vessel with cover off, showing the orifice and the small depressions in which the gold-leaf, &c. were placed.

Fig. 3. Receiver without stopper.

Fig. 4. The stopper.

Fig. 1.

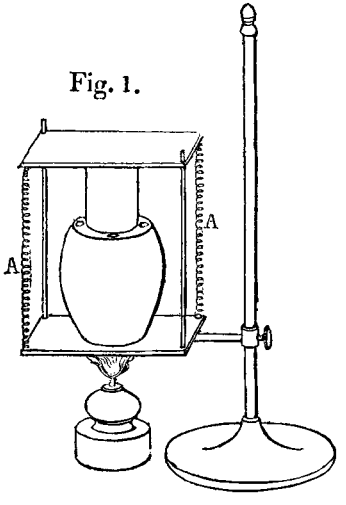

Fig. 2.

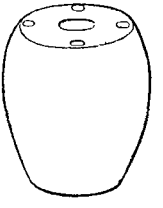

Fig. 3.

Fig. 4.

XXV. *On certain new Combinations of Albumen, with an Account of some curious Properties peculiar to that Substance. By* Golding Bird, *F.L.S., F.G.S., Senior Fellow of the Physical Society of Guy's Hospital, &c.**

1. In the course of the following observations I shall avoid any unnecessary reiteration of facts already well known to chemists, and confine myself to referring to them only when they are required to explain any circumstances connected with those new modifications or combinations of albumen which have fallen under my notice. Our knowledge of the properties of albumen, although more extended than that

* Communicated by the Author.

of most other animal matters, is nevertheless very limited, which limitation arises, in all probability, from its comparatively weak affinity for other bodies, which prevents our becoming acquainted with anything like very prominent or interesting features; I am however convinced that the study of the chemical nature of albumen will reward the investigator with a richer harvest of facts than that of any of the other proximate constituents of the animal frame, as well from its prevalence under some modification or other in every secretion in the body, as from its being the chief constituent of the circulating fluid, and constituting, if I may be allowed the expression, the type of the albuminous principles (*properly* so called) of the blood, and the pabulum from which the different secretions are formed and the waste of the body repaired. Indeed, by a synthetic method, founded to a certain extent upon some of the novel properties of albumen I am about to mention, I trust to be able in a future paper to prove that many, if not all the secretions contain albumen, although its presence has not been suspected, or if suspected not detected, and that they are indebted to the presence of a peculiar combination of this principle for many of their most prominent characters. In the course of my investigations I had frequently occasion to observe that albumen procured from different sources frequently differed slightly in its behaviour to reagents, and an ignorance of this fact led at first to considerable discrepancy in the results of my experiments; thus I may observe that the white of egg and the albuminous secretions of serous surfaces very closely resembled each other, but differed in degree of solubility and many other minor properties from the albumen of serum of blood, which I have generally made the subject of my experiments, after freeing it from fat by agitation with sulphuric æther; and to this form of albumen I shall constantly refer in the course of the following observations.

2. Some serum freed from fat (1.) was mixed with a sufficient quantity of a solution of pure soda to cause it strongly to affect turmeric paper; the heat of a water-bath was applied, the mixture being constantly stirred: in a short time it appeared to solidify, forming a pale yellowish transparent jelly which scarcely at all affected turmeric paper. Distilled water being then added, and heat again applied, a nearly limpid, but somewhat mucilaginous solution of albuminate of soda resulted, which became quite transparent by filtration; it was not at all affected by boiling or the addition of alcohol, but was precipitated by the acids, solutions of chlorine, alum, acetate of lead, bichlorides of iron and mercury, sulphate of copper, ferro-

cyanate of potash (after the addition of acetic acid), and tincture of galls; reactions quite characteristic of solutions of alkaline albuminates.

3. A solution of albuminate of soda (2.) was diluted considerably with cold distilled water and placed in a tall cylindrical glass vessel; through this fluid a current of carbonic acid gas was passed, the tube from which the gas issued being sufficiently long to reach the bottom of the vessel: in a few minutes the fluid, before transparent, became opake, and rapidly deposited a copious precipitate of albumen in the state of a beautifully white, impalpable powder; the acid gas being allowed to pass for some time longer, the precipitate gradually disappeared until the whole was as limpid as before the experiment. The solution thus obtained was acid, and consequently reddened litmus-paper, whereas before the experiment it reddened turmeric; it afforded a copious deposit with those reagents which precipitate solutions of albumen in mere water, or when dissolved by acids, but not with those which affect solutions of albumen in the alkalies only: thus, ebullition caused a considerable deposit, as also did nitric acid, tincture of galls, bichloride of mercury, and alum; whereas the dilute acids and perchloride of iron did not disturb the limpidity of the fluid, although, as before stated, prior to the passage of the acid gas they produced copious precipitates. Heat, I have already stated, caused a considerable deposit of albumen in the same manner as from a mere aqueous solution of albumen which had not undergone coagulation, but differed in requiring a higher temperature, a full boiling-heat being necessary to produce a considerable precipitate. Ammonia when very dilute caused a precipitate also, which readily dissolved in an excess of the precipitant; the action of heat was of course accompanied with a copious evolution of carbonic acid gas. From these facts I was induced to conclude that the albumen previously existing in combination with the soda, had left that alkali to combine with the carbonic acid, thus playing the part of a base or electro-positive element, leaving the soda in the state of bicarbonate, that salt being of course formed by the action of the carbonic acid added: the solution might thus be supposed to contain a mixture of the carbonates of soda and albumen with an excess of carbonic acid. To this explanation it might be objected, that as alkaline bicarbonates are known to dissolve albumen, the acid gas had only converted the alkali into a bicarbonate, which thus held the albumen in solution: if this were true, how can the precipitation of albumen on the first passage of the gas be explained, unless it be supposed that the neutral alkaline carbonate which is first formed,

is incapable of holding in solution so large a quantity of albumen as the free alkali, or its bicarbonate; an assumption directly opposed to fact, as I shall have occasion to show in another place: besides which, the action of reagents ought to differ, and instead of those only which precipitate acid solutions of albumen producing a turbidity, a troubling should be produced by those also which affect its alkaline solution, for surely the solution of an animal matter in a carbonated alkali approaches less to the nature of an acid than to that of an alkaline solution.

4. I next attempted to form a solution of albumen in carbonic acid, excluding the agency of alkali, which if successful would, I considered, at once demonstrate the real nature of the combination; but in this I experienced considerable difficulty, for when a current of carbonic acid gas was passed through an aqueous solution of albumen (1.), no distinct combination was obtained; and on attempting in a similar manner to dissolve albumen previously coagulated by the action of heat or acids, I failed to obtain satisfactory results, from the close state of aggregation in which the albumen was obtained appearing to present a considerable resistance to the solvent action of the acid. I at length succeeded by precipitating albumen from serum of blood by means of alcohol, well washing the precipitate until all traces of alcohol were removed, (the vessel in which the precipitation was performed being immersed in ice-cold water to prevent the action of the evolved heat on the albumen,) carefully avoiding any unnecessary exposure to the air, which, by drying it, might serve to lessen its solubility in the acid. A portion of this finely divided albumen was diffused through cold water, and submitted to the action of a current of carbonic acid gas; after a short time it *entirely dissolved*; but the solution was not perfectly limpid, nor did it become so by filtration. In preparing this solution care must be taken to add a sufficient quantity of water, otherwise a considerable quantity of albumen will be carried mechanically out of the fluid by each bubble of gas, and being deposited on the sides of the vessel, will dry rapidly, and on being returned to the fluid will be found to have lost much of its solubility in the acid; and it is very remarkable how large a quantity of albumen can (by this kind of inverted filtration) be carried beyond the influence of the gas. The finely divided albumen obtained by passing a *limited* quantity of carbonic acid into albuminate of soda (2.), after well washing, may be substituted for that precipitated by alcohol, although it must be observed that it is not quite so readily soluble as that obtained by the latter process, owing to its having undergone

some modification, probably in its state of aggregation, difficult to unravel. If the precipitated albumen is merely digested in an aqueous solution of carbonic acid in a closed flask for some hours, as much appears to be taken up as if a *current* of the gas was used; and hence I have been led to conclude that the solubility of the albumen is not so much owing to the formation of a definite soluble compound (carbonate?) as to its being merely dissolved in the quantity of acid gas which water is capable of holding in solution at ordinary atmospherical pressure and temperature.

5. The solution of albumen in carbonic acid behaves to reagents like a mere aqueous solution,—as dilute serum of blood, with, as far as I know, a single exception, and this is the action of very dilute ammonia, which produces a precipitate of albumen soluble in an excess of the alkali. Heat produces a deposit of albumen with a simultaneous evolution of carbonic acid gas; nitric acid, tincture of galls, acidulated ferrocyanate of potassa, and bichloride of mercury all produce copious precipitates. By exposure to the air it does not very readily become turbid, the carbonic acid being very slowly evolved: after the lapse of a week, however, the albumen is deposited in a white impalpable form. The presence of carbonic acid in these solutions of albumen appears to prevent its ready precipitation by nitric acid, several drops being required to produce a considerable troubling; and on this account I am accustomed to use the nitrohydrochloric acid as a preferable precipitant when I have the detection of albumen in an animal fluid in view, as the action of this acid does not appear to be so liable to be affected by carbonic acid.

6. Wishing to ascertain with greater accuracy whether the albumen precipitated from its solution in soda by carbonic acid, depended for its resolution upon the formation of a compound with that acid, or upon the solvent action of the bicarbonate necessarily formed, I availed myself of Dr. Stevens's adaptation of Prof. Graham's law of the diffusion of gases, by placing a glass vessel filled with the solution (3.) under a large receiver full of hydrogen gas inverted over water. In twelve hours the apparatus was examined, and the fluid subjected to experiment, previously quite limpid, was found to be very turbid from the deposition of its albumen; the carbonic acid having been abstracted by the hydrogen gas. A modification of this experiment was then made by placing over the fluid subjected to the hydrogen gas, a capsule filled with lime-water: the carbonic acid being abstracted as before, was absorbed by the lime-water, causing the precipitation of car-

bonate of lime, which occurring simultaneously with the precipitation of albumen appeared to bear so near a relation to cause and effect that there can, I think, no longer remain a doubt as to the solvent nature of carbonic acid with regard to albumen. These experiments prove moreover another interesting fact, viz. that however energetic a solvent for albumen the uncombined alkalies may be, their carbonates must be regarded as comparatively powerless, contrary to the generally received opinion; for the same quantity of soda must necessarily have existed in the fluid after, as before its being subjected to the action of the carbonic acid, and subsequently of the hydrogen, the only difference being that it had become converted into a carbonate, whereas before the experiment it was pure and uncombined, *quoad* carbonic acid.

7. I was next desirous to ascertain what was the degree of solvent action capable of being exerted on coagulated albumen by alkaline carbonates, and whether this solvent power depended upon any partial decomposition of the salt employed, the acid or base being set free; I therefore precipitated albumen as before from fresh serum by means of alcohol, well washed it with cold distilled water, and divided it into four portions which I placed in as many flasks, the first of which was filled up with a solution of bicarbonate of soda, the second with a solution of the carbonate of soda, the third with water impregnated with carbonic acid, and the fourth with recently boiled distilled water; they were allowed to digest for twelve hours, and then examined after filtration with the following reagents:

Solvent employed.	Ebullition.	Nitric Acid.	Acetic Acid.	Sol. of Alum.	Bichloride of Mercury.
1. Bicarb. soda.	Dense opacity.	Copious precipitate.	Precipitate sol. in excess of acid.	Copious precipitate.	Copious precipitate.
2. Carb. soda.	Opacity.	Do.	Do.	Do.	Do.
3. Sol. of carbonic acid in water.	Copious precipitate.	Do.	—	?	Do.
4. Recently boiled water.	—	—	—	—	—

The water in the fourth flask was used for the purpose of

ascertaining whether the precipitated albumen contained any of the soluble form of that principle which might have been mechanically carried down with it, but that this was not the case was satisfactorily proved by the five reagents employed not in the least disturbing the limpidity of the filtered fluid. It will be observed that ebullition produced a copious troubling in the solution of bicarbonate of soda that had been digested on the albumen in the first flask, as if a portion of uncoagulated albumen had been present, which I have just shown was not the case. How then can it be accounted for? Might it not be suggested that the salt employed had been decomposed into a neutral carbonate and free acid, which latter dissolved a portion of albumen, the carbonate being also partially decomposed into free alkali, which by dissolving albumen formed an albuminate of soda, whilst the portion of carbonic acid deserted by its base united to another portion of albumen, and thus the solution might be supposed to consist of undecomposed carbonate of soda, albuminate of soda, and carbonate of albumen (if this expression may be *provisionally* admitted). With regard to the contents of the second flask, in which the neutral carbonate was used, this appears to have undergone an analogous decomposition, for like the contents of the first flask, we find them present the same phænomena with reagents as would be produced by a mixture of solutions of albumen in carbonic acid and albuminate of soda; but experiments are required to clear up the obscurity enveloping this point.

8. An interesting field for investigation thus appeared to present itself in the examination of the action of albumen on the alkaline carbonates, the investigation of which I commenced with great care, and obtained some highly interesting and unexpected results; but not having quite concluded my examination of this part of my subject in consequence of the multitudinous repetition of experiments required to obviate the various sources of fallacy peculiarly incident to investigations in organic chemistry, I am compelled to defer their publicity for some weeks, when I trust to be able to communicate some curious and important facts on this interesting subject.

44 Seymour-street, Euston-square,
July 6, 1836.